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(54) **Flow-drilling tool**

(57) A cylindrical shank 2, Fig. 1, is fitted in a chuck for rotation of the tool. A shoulder 4 and operative portion 5 having a tapered lower end 6 are defined between plane parallel surfaces whose spacing is not greater than half the maximum width of the operative portion. The lower edge of the shoulder 4 and the edges of the operative portion 5 are rounded with a radius of curvature less than half the width of the operative portion and are made of hard carbide strips 7 attached to the edges in various ways or applied as a coating.

The tool may have three equally spaced arms 10, Fig. 6, instead of two diametrically opposite arms. When a screw thread is to be formed in the hole created by the tool the shoulder is replaced by a profiled thread cutter 13, Fig. 8.

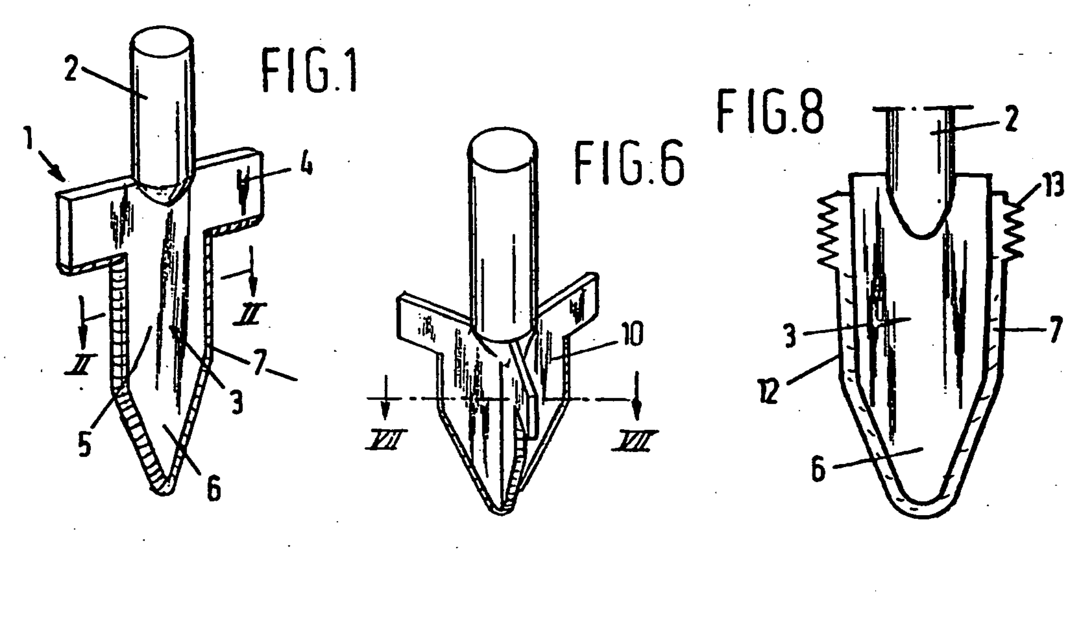

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FIG.1

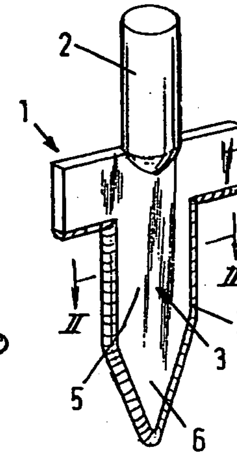


FIG.5

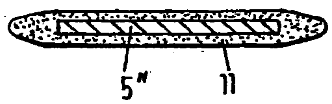


FIG.2

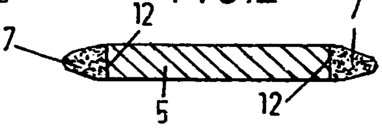


FIG.3

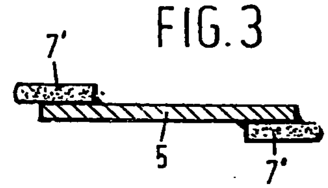


FIG.6

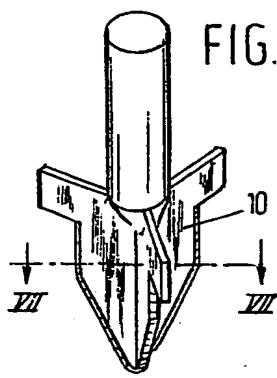


FIG.4

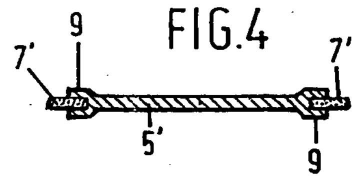


FIG.7

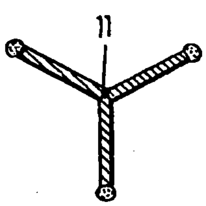
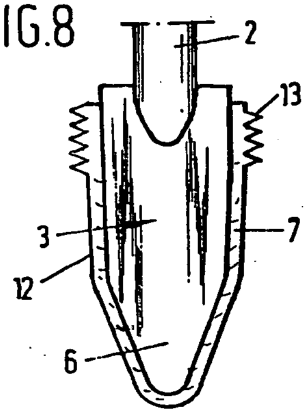


FIG.8



SPECIFICATION

Flow-drilling tool

This invention relates to a mandril adapted to be rotated about its longitudinal axis at high speeds for making a hole surrounded by a collar in a metal sheet or tube wall exclusively by means of frictional heat and pressure, said mandrel comprising a cylindrical shank for engagement by a chuck, a widened shoulder, and an operative portion contiguous with said shoulder and having a width defining the diameter of the hole, said operative portion being tapered adjacent its lower end.

Tools of this type, sometimes called flow-drilling tools, are known from German patent 23 59 794. In the known flow-drilling tool, in addition to the shank adapted to be gripped by a chuck, the shoulder too has a cylindrical shape, while the operative portion contiguous with the collar is of approximately triangular cross-sectional configuration with rounded corners.

A similar flow-drilling tool is described in German patent 25 52 665. In it, the triangular main shape has been abandoned, and the circumference of the operative portion is determined, as viewed in cross-section, by arcs of different radius of curvature, said arcs merging one into another.

Flow-drilling tools of the above type are made from sintered carbide material, which is extremely difficult to machine, and the rather complicated shape can only be produced by grinding, starting from cylindrical rod material. The manufacture of flow-drilling tools of substantially the same form requires great skill, and the grinding operation is in addition expensive.

It is an object of the present invention to provide a flow-drilling tool of the above-described type which is considerably simpler and therefore cheaper to make. To this effect, the flow-drilling tool according to the invention is characterized in that the shoulder and the operative portion of the mandril are bounded by two plane parallel surfaces, the thickness of the operative portion being maximally equal to half the largest width of said operative portion, the other boundary surfaces thereof being rounded with a radius of curvature less than half the width of said operative portion.

Preferably, the thickness of the operative portion is maximally 1/3rd of the largest width thereof.

Hitherto it has been assumed that the shape of the flow-drilling tool has to be self-centering, which means that at least three side edges of the drill would have to be in contact with the wall of the hole to be drilled, so that the main form of the drill, in cross-section, would have to be triangular. Surprisingly it has been found that the expected difficulties in centering do not occur with a drill of flat shape. Accordingly, for the manufacture of flow-drilling tools, it is possible to start from a plane sheet of sintered carbide material, and only the side edges thereof and the lower edge of the collar have to be ground for these parts to be provided with the desired rounding. This produces a very considerable material and cost of machining. The resulting saving in cost is at least 30%. A flat drill can then be fixed in some suitable manner in a cylindrical shank to enable the tool to be gripped by a rotatable chuck.

Flow-drilling tools having flat side surfaces are known per se from French patent 1,189,384, but these prior flow-drilling tools are not collared. The operative portion of this prior drill is of square cross-sectional configuration, with the diagonal thereof being equal to the diameter of the hole to be made, the four edges of the tool being in contact with the wall of the hole to be drilled, so that this is not a flat drill within the meaning of the present application.

The advantages obtained with a flat flow-drilling tool can be enhanced considerably by making the drill of two different materials. The lower edge of the shoulder and the side edges of the operative portion of the mandril consist in that case preferably of strips of sintered carbide metal secured to a T-shaped body of a different material. The marginal strips of sintered carbide metal may be connected to the flat surfaces of the T-shaped mandril body, for example, by means of soldering, and they may also be connected to the side edges and the lower edge of the mandril body of a different material by means of an adhesive.

The carbide strips on the side edges of the mandril body may also be provided by vapour deposition. In that case, not only are the side edges of the mandril body provided with a coating of carbide, but the entire surface.

For making holes of larger diameter, for example, larger than 15 mm, it may be necessary, to increase the stiffness, to form the shoulder and the operative mandril portion from three interconnected body members radially disposed and each having the form of a T-shaped mandril body divided along the centerline thereof, and with marginal strips of sintered carbide being secured to the side edges and the lower edge thereof.

Instead of a shoulder, the flat flow-drilling tool may be provided with flutes having the same width as the mandril portion contiguous therewith. Such a drill permits drilling the hole and forming screwthread therein in one operation.

Embodiments of the flow-drilling tool according to the invention will now be described with reference to the accompanying drawings. In said drawings:

Figure 1 shows a flat flow-drilling tool according to the invention;

Figure 2 shows a cross-sectional view of the

line II–II of Fig. 1;

Figures 3–4 show cross-sectional views similar to Fig. 2, with the marginal strips being secured to the mandril body in a different manner;

Figure 5 shows a cross-sectional view similar to Fig. 2, with a carbide coating being vapour deposited on the mandril body;

Figure 6 shows a perspective view if a star-shaped mandril according to the invention;

Figure 7 shows a cross-sectional view on the line VII–VII of Fig. 5; and

Figure 8 shows a flow-drilling tool which is also suitable for rolling screwthread.

Fig. 1 shows a flat mandril or flow-drilling tool 1 comprising a cylindrical shank 2 to which a T-shaped mandril body 3 has been secured. This body 3 comprises a broad shoulder 4 and an operative portion 5 contiguous therewith, the lower end 6 of which has a tapered configuration. Except for the shank 2, the body 3 could be formed of carbide metal. Fig. 1 shows a preferred embodiment in which body 3 consists of a material which only needs to be sufficiently rigid, while the lower edge of shoulder 4 is provided with carbide strips 8 and the side edges of body 3 are provided with carbide strips 7. The carbide strips 7 must have a bend approximately in the middle for them to be able to follow the bevelled edge of body 3. Strips 7 may be made to fit a mandril body 3 in the form shown. When strips 7 and 8 have been applied to the lower and side edges of the mandril body, these may be given the desired radius of rounding by grinding.

The carbide strips 7 and 8 may be secured to the lower and side edges of body 3 by means of adhesive. In Fig. 2, an adhesive layer between the carbide strip and the operative body portion 5 is shown at reference numeral 12.

The carbide strips 7 may also be connected to the operative body portion 5 by other means, as shown in Fig. 3. In this embodiment the flat carbide strips 7′ are soldered to the flat surfaces of the body, for which a soldering method must be used which makes the soldered joint resistant to high temperatures.

Fig. 4 shows still another way of connecting the carbide strips 7′ to the operative body portion 5′. The side edges of the operative portion 5′ are provided with forked edges, in which strips 7′ are fixed.

The above flow-drilling tools are all suitable for forming holes of up to approximately 15 mm (in materials having a tensile strength up to 120 kg/mm^2). With larger diameters, or very hard material, a higher stiffness of the flow-drilling tool is required. This higher stiffness can be obtained by interconnecting half-T-shaped body portions 10 (see Fig. 5) along a lateral edge to form a star-shaped mandril body, to the side edges of which carbide strips may be applied in the manners described above.

It should be noted that the carbide strip provided at the lower edge of shoulder 4 may be made in such a manner that the collar to be formed around the bore hole is provided with a recess, as described in German patent 28 02 229.

Instead of pre-fabricated carbide strips 7, 8 secured to a mandril body of differeny material, as shown in Figs. 1–4, vaporous carbides may be deposited on a carrier 5″ (see Fig. 5), using the CVD process (chemical vapour deposition). Carrier 5″ is coated throughout its entire surface with a layer of carbides 11, only the operative side edges of which need to be ground for imparting the correct shape to the drill.

Flow-drilling tools with a shoulder are used to level the upper surface of the collar formed around the hole being drilled, so that this upper surface may serve as a sealing surface. In a second operation, screwthread is cut or rolled in the drilled hole. Flat flow-drilling tools lend themselves excellently to making the hole and forming screwthread therein in one operation. In that case the shoulder on the drill must be omitted, because levelling the upper surface of the collar formed around the hole cannot be effected simultaneously with cutting the thread.

Fig. 8 shows a flow-drilling tool of this type. Secured to a shank 2 is a flat body 3 having a tapered lower end. Carbide strips 7 are secured to this body in a manner as shown in one of the Figs. 1–4. Naturally the embodiment shown in Fig. 5 can also be used. By grinding, the carbide strips 7 are provided at the top with flutes 13 for rolling screwthread. The portion 12 contiguous with flutes 13 is slightly tapered in the downward direction, preferably about 3°. This facilitates rolling screwthread after the formation of the bore hole. Even if the drill is not provided with flutes 13, the operative mandril portion is provided with a taper of 3° to facilitate withdrawing the mandril from the bore hole.

CLAIMS

1. A flow-drilling mandril adapted to be rotated about its longitudinal axis at high speeds for making a hole surrounded by a collar in a metal sheet or tube wall exclusively by means of frictional heat and pressure, said mandril comprising a cylindrical shank for engagement by a chuck, a widened shoulder, and an operative portion contiguous with said shoulder and having a width defining the diameter of the hole, said operative portion being tapered adjacent its lower end, characterized in that the shoulder (4) and the operative portion (5, 6) are bounded by two plane parallel surfaces, the thickness of the operative portion (5) being maximally equal to half the largest width of said operative portion (5),

the other boundary surfaces thereof being rounded with a radius of curvature less than half the width of said operative portion (5).

2. A tool according to claim 1, characterized in that the thickness of the operative portion is maximally 1/3rd of the largest width of said portion.

3. A flow-drilling mandril comprising a cylindrical shank for engagement by a chuck, a widened shoulder, and an operative portion contiguous with said shoulder and having a width defining the diameter of the hole, said operative portion being tapered adjacent its lower end, the shoulder and the operative portion being bouned by two plane parallel surfaces, the thickness of the operative portion bing maximally 1/3rd of the largest width of said portion, characterized in that the lower edge of the shoulder and the side edges of the operative mandril portion consists of strips of sintered carbide, secured to a T-shaped body of a different material.

4. A tool according to claim 3, characterized in that the edge strips (7, 8) of sintered carbide are connected to the flat walls of the T-shaped body (3) by means of soldering.

5. A tool according to claim 3, further characterized in that the edge strips (7, 8) of sintered carbide are connected to the side edges and the lower edge of the T-shaped mandril body by means of an adhesive.

6. A flow-drilling mandril comprising a cylindrical shank for engagement by a chuck, a widened shoulder, and an operative portion contiguous with said shoulder and having a width defining the diameter of the hole, said operative portion being tapered adjacent is lower end, the shoulder and the operative portion being bounded by two plane parallel surfaces, the thickness of the operative portion being maximally 1/3rd of the largest width of said portion, characterized in that said mandril comprises a T-shaped body (5'') coated throughout is entire surface with a coating of carbides (11).

7. A tool according to claim 3, characterized in that the shoulder (4) and the operative mandril portion (5) comprise three interconnected body members (10) disposed in the form of a star and each having the form of a T-shaped mandril body (3) divided along the centerline thereof, and with marginal strips (7, 8) of sintered carbide being secured to the side edges and the lower edge thereof.

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